Impact of Nitrogen Deposition on California Ecosystems and Biodiversity

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The Issue

All Californians contribute to the state's nitrogen emissions; whether by driving to work, eating a meal, or using electricity. These nitrogen emissions (a component of "acid rain") are the result of fossil fuel combustion, and in the West the three major producers of nitrogen emissions are transportation, agricultural production, and industrial activities; including electricity production.

The left side of the fence is invaded by exotic species.

Nitrogen emissions in California have decreased over the last 20 years, but ecosystems within the South Coast air basin receive the highest nitrogen deposition in the country (25 to 45 kilograms per hectare per year), and can exceed 90 kg/ha/yr.[1] These emissions not only result in higher ground-level ozone (because nitrogen oxides, or NO_X, play a major role in the formation of ozone), their deposition on land or in aquatic environments can degrade sensitive ecosystems. In fact, ecosystem structure and diversity can be negatively affected by nitrogen concentrations as low as 3 to 8 kg/ha/yr.[2] Nitrogen deposition can cause decreased plant function, promote exotic species,[3] and leach into surface and ground waters, which can lead to accelerated algae growth and oxygen depletion in recipient water bodies.

Power plants release NO_X, nitrogen dioxide (NO_2), and ammonia (NH_3), which is deposited in local and downwind habitats.[4] In 2002, California's electric utilities (excluding cogeneration

[1] PIER-EA Agreement with University of California (UC) Santa Barbara and UC Riverside to Assess Nitrogen Deposition Models and Habitat Impacts in California. September 12, 2003.
[2] Ibid.
[3] For example, during the Metcalf Energy Center siting procedure, one analysis concluded that non-native grasses would use the additional nitrogen more effectively than native grasses, and thereby overtake the native grasses, and that as little as 5 kg/ha would spur that conversion. (Scholz, Scott. October 27, 1999. Community News. California Energy Commission Biological Issues Workshop for Metcalf Energy Center. www.energy.ca.gov/sitingcases/metcalf/documents/intervenors/2000-02-08_community_news.html.
[4] PIER-EA Agreement with UC Santa Barbara and UC Riverside to Assess Nitrogen Deposition models and Habitat Impacts in California. September 12, 2003.

plants) emitted over 62 tons per day of NO_X. To address this source of nitrogen deposition, power plant licensing procedures consider the impacts of nitrogen deposition on air quality and terrestrial and aquatic ecosystems in their environmental reviews.[5]

An assessment of factors that affect nitrogen deposition and its effect on California's ecosystems and biodiversity is necessary to protect habitats and species that may be particularly sensitive to such deposition. Energy Commission siting staff has an immediate need for this type of analyses for two important reasons: (1) nitrogen emission impacts to air quality are evaluated for every power plant application, and (2) ecological impacts of nitrogen deposition have been a concern on a number of recent power plant siting cases.[6] The issue is expected to be an increasing concern because of recent work indicating that nitrogen deposition can have severe impacts on ecosystem function and integrity.

Project Description

In this project, PIER-EA funded work by the University of California at Santa Barbara Riverside to better characterize and quantify the impact of nitrogen deposition on California's ecosystem health.

Researchers reviewed existing information and research on the effects of nitrogen deposition on sensitive habitats in California, assessed nitrogen-limited habitats and nitrogen-saturated soils and ecosystems in the state, and identified associated sensitive species. The ecological screening ranked special-status species according to potential nitrogen deposition exposure, habitat type, and life history, using a geographic information system (GIS) and several existing data sources.

Energy Commission siting staff and California Air Resource Board representatives were instrumental in developing this research.

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objectives:

- **Providing environmentally sound energy.** The identification of specific areas and species that are susceptible to excessive nitrogen deposition will further enhance the ability of California Energy Commission staff to make informed choices about power plant siting and to protect endangered habitat and species. Improved understanding of habitat sensitivity to nitrogen deposition will support the development of better policy and management.

- **Providing reliable and affordable energy services.** Power plant licensing decisions require accurate data on a host of environmental subjects, any one of which may delay or derail the process. This project identified the areas within California where nitrogen deposition can have serious consequences, as well as those areas where nitrogen deposition should not pose a significant problem. This information will help speed the licensing process and facilitate a more accurate assessment of deposition levels, which will result in fair mitigation

[5] Ibid.
[6] The Metcalf Energy Center Power Project, Otay Mesa Generating Project, Pico Power Project, and Los Esteros Critical Energy Center.

requirements for power plant developers. As a result, much-needed power generation should be built more quickly, and at a lower cost.

Results

The major documented impact of nitrogen deposition on California terrestrial biodiversity is the increase of invasive annual grasses in low biomass ecosystems, resulting in species loss. The tools developed include a 36 x 36 kilometer map of total nitrogen deposition for 2002, developed from the Community Multiscale Air Quality Model (CMAQ). The map was overlaid with: sensitive habitats, the Forest Resource and Protection vegetation map, and animal and plant species occurrence data from the California Natural Diversity Data Base. A preliminary analysis was conducted of species life history and habitats that may be affected by nitrogen deposition.

A workshop presenting research results was held in December 2006.

Final Report

This project's final report is *Impacts of Nitrogen Deposition on California Ecosystems and Biodiversity* (CEC-500-2005-165). It is posted at the California Energy Commission website, at www.energy.ca.gov/2005publications/CEC-500-2005-165/CEC-500-2005-165.PDF.

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